Package 'siRSM'

February 20, 2015

Type Package

Title Single-Index Response Surface Models

Version 1.1

Date 2014-07-15

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Description This package fits single-index (quadratic) response surface models.

License GPL-2

Imports rsm, MASS, foreach, doSNOW, parallel

NeedsCompilation no

Repository CRAN

Date/Publication 2014-07-18 07:09:29

R topics documented:

siRSM-package *siRSM: Single-index Response Surface Models*

Description

This package provides tools for fitting what we call "single-index response surface models", that is, models of the form `y=f(u,v)+e`, where `f(u,v) ~ 1 + u + v + u^2 + uv + v^2`, `u=t(w)%*%U`, and `v=t(w)%*%V`.

Details

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Version:	1.1
Date:	2014-07-15
License:	GPL-2

Author(s)

Huan Cheng, Mu Zhu

Maintainer: Mu Zhu <m3zhu@uwaterloo.ca>

References

Cheng H, Zhu M, Chan VW, Michela, JL (in preparation), "Single-index response surface models".

See Also

siRSM, surface.test, surface.stats, ci.index, ci.surface

Examples

```
## Not run:
# load illustrative data set provided within the package
data(EdwardsMBA)

# parse the variables
y=EdwardsMBA[,'AVGSAT4']
U=EdwardsMBA[,c('PCPRE','DMPRE','EIPRE','MRPRE')]
V=EdwardsMBA[,c('PCACT','DMACT','EIACT','MRACT')]

# fit the model
m1=siRSM(y,U,V)
```

```
# look at the model
m1
plot(m1)

# F-test of surface curvature
surface.test(m1)

# inference on the index (using just 10 bootstrap samples here)
ci.index(y,U,V,B=10)

# obtain statistics of the response surface (conditional on the estimated index)
surface.stats(m1)

# inference for these surface statistics (again, conditional on the estimated index)
ci.surface(m1)

# fit an interaction-only model
m2=siRSM(y,U,V,interaction.only=TRUE)
plot(m2)

## End(Not run)
```

`ci.index` *Condidence Intervals for Single Index*

Description

Computes 95% bootstrap confidence intervals for the single index.

Usage

```
ci.index(y, U, V, B=100, use.parallel=TRUE, ...)
```

Arguments

`y`	vector, response
`U`	matrix, whose columns are covariates for factor one
`V`	matrix, whose columns are covariates for factor two
`B`	number of bootstap samples to take
`use.parallel`	if TRUE, exploits multiple cores by using **foreach**, **doSNOW**, etc
`...`	other arguments for `siRSM`, e.g., `interaction.only=TRUE`, `trial=10`

Value

A data.frame specifying the lower 2.5% and upper 97.5% confidence limits, the mean, and the standard error for each coordinate of the index.

Author(s)

Mu Zhu

`ci.surface` *Conditional Inference of Response Surface*

Description

Computes 95% bootstrap confidence intervals for various features of the quadratic response surface, CONDITIONAL on the single index.

Usage

```
ci.surface(obj, B=500, use.parallel=TRUE)
```

Arguments

`obj`	an object of class `siRSM`, typically result from `siRSM`
`B`	number of bootstrap samples
`use.parallel`	if TRUE, exploits multiple cores by using **foreach**, **doSNOW**, etc

Value

In all components below, the lower 2.5% and upper 97.5% confidence limits, the mean, and the standard error are given:

`stationary.point`	stationary point, (`u0, v0`)
`prin.ax.1`	1st principal axis, intercept (`p10`) and slope (`p11`)
`prin.ax.2`	2nd principal axis, intercept (`p20`) and slope (`p21`)
`beta`	coefficients defining the quadratic response surface, `b0, b1, ..., b5`
`line.congr`	slope (`ax`) and curvature (`ax2`) along the congruence line, `u-v=0`
`line.incongr`	slope (`ax`) and curvature (`ax2`) along the congruence line, `u+v=0`

Author(s)

Huan Cheng, Mu Zhu

draw.full.quadratic *Functions for plotting various siRSMs*

Description

Internal function called by `plot.siRSM`. Do NOT use.

Usage

```
draw.interaction.only(x, xname=NULL, yname=NULL, zname=NULL)
draw.full.quadratic(x, xname=NULL, yname=NULL, zname=NULL, center='zero',
  debug=FALSE)
```

Arguments

`x`	an object of class `siRSM`
`xname`	character string, name for first (composite) factor
`yname`	character string, name for second (composite) factor
`zname`	character string, name for response
`center`	if 'zero', centers the surface plot at `(0,0)`
`debug`	can be turned on for debugging purposes

Author(s)

Huan Cheng, Mu Zhu

EdwardsMBA *MBA Data Set from Edwards (1994)*

Description

A real data set to illustrate single-index response surface models. Among a group of MBA students, job satisfaction is highest when preference for various kinds of work matches the extent to which they actually engage in those kinds of work.

Usage

```
data(EdwardsMBA)
```

Format

A matrix containing 172 rows (observations) and 9 columns (variables):

PCPRE	preferences (PRE) for 'planning and coordinating' (PC) kind of work
DMPRE	preferences (PRE) for 'decision making' (DM) kind of work
EIPRE	preferences (PRE) for 'exchanging information' (EI) kind of work
MRPRE	preferences (PRE) for 'motivating and rewarding others' (MR) kind of work
PCACT	actual engagement (ACT) in 'planning and coordinating' (PC) kind of work
DMACT	actual engagement (ACT) in 'decision making' (DM) kind of work
EIACT	actual engagement (ACT) in 'exchanging information' (EI) kind of work
MRACT	actual engagement (ACT) in 'motivating and rewarding others' (MR) kind of work
AVGSAT4	a measure of job satisfaction

References

Edwards JR (1994), "The study of congruence in organizational behavior research: Critique and a proposed alternative," *Organizational Behavior and Human Decision Processes*, 58, pp. 51-100 (erratum, 58, pp. 323-325).

`multi.run` *Fit siRSM by Trying Multiple Initial Values*

Description

Internal function called by `siRSM`. Do NOT use.

Usage

```
multi.run(y, X, Z, rep, interaction.only=FALSE, use.parallel=TRUE)
```

Arguments

y	vector, response
X	matrix, whose columns are covariates for factor one
Z	matrix, whose columns are covariates for factor two, must be of same size as X
rep	number of different initial values to try — if unspecified, the default is twice the dimension of the index
interaction.only	fit an interaction-only model
use.parallel	if TRUE, exploits multiple cores by using **foreach**, **doSNOW**, etc

Note

In these more rudimentary functions (not to be called by user), `U` is referred to as `X`, and `V` as `Z`, due to "historical reasons". Currently, multiple RANDOM initial values are used. In the future, we'd like to switch to using a space-filling design.

Author(s)

Huan Cheng, Mu Zhu

`single.run` *Fit siRSM Once Based on One Initial Value*

Description

Internal function called by `siRSM`. Do NOT use.

Usage

```
single.run(data, w0, int.only=FALSE, eps=0.005, precision=1e-6, max.iter=10000,
  debug=FALSE, trace=TRUE)
```

Arguments

`data`	`y, X, Z` together
`w0`	initial guess
`int.only`	fit an interaction-only model
`eps`	step size for gradient descent
`precision`	convergence criterion
`max.iter`	maximum number of iteractions
`debug`	can be turned on for debugging
`trace`	if TRUE, reports progress as function runs

Note

In these more rudimentary functions (not to be called by user), `U` is referred to as `X`, and `V` as `Z`, due to "historical reasons".

Author(s)

Huan Cheng, Mu Zhu

siRSM *Single-index Response Surface Model*

Description

This is the main function for users to call.

Usage

```
## Default S3 method:
siRSM(y, U, V, trial, interaction.only=FALSE, use.parallel=TRUE)

## S3 method for class 'siRSM'
print(x, ...)

## S3 method for class 'siRSM'
plot(x, ...)
```

Arguments

y	response vector
U	matrix, whose columns are covariates for first factor
V	matrix, whose columns are covariates for second factor, must have same dimension as U
trial	number of different initial values to try — if missing, defaults to 2*K, where K = ncol(U) = ncol(V)
interaction.only	fit an interaction-only (rather than a full-quadratic) model
use.parallel	if TRUE, tells underlying utility function multi.run to exploit multiple cores by using **foreach**, **doSNOW**, etc
x	an object of class siRSM, often result of siRSM
...	arguments for plot include: xname=character string, name for first (composite) factor; yname=character string, name for second (composite) factor; zname=character string, name for response; center=if 'zero', centers the surface plot at (0,0)

Value

An object of class siRSM. For most users, the most useful elements are:

w	the estimated single index vector
coef	the coefficients of the corresponding response surface

Author(s)

Huan Cheng, Mu Zhu

surface.stats *Statistics of Quadratic Response Surface*

Description

Computes stationary point, 1st and 2nd principal axes of the quadratic response surface, shapes and curvatures along the congruence and incongruence lines, as well as various parameters useful for `plot.siRSM`.

Usage

```
surface.stats(obj)
surface.stats.main(b, xlim, ylim)
```

Arguments

`obj`	an object of class `siRSM`, often the result of `siRSM`
`b`	coefficients of the response surface, e.g., `obj$coef` where `obj` is an object of class `siRSM`
`xlim`	x-boundaries in 3D (x,y,z)-perspective plot — used when `surface.stats.main` is called internally by `plot.siRSM`
`ylim`	y-boundaries in 3D (x,y,z)-perspective plot — used when `surface.stats.main` is called internally by `plot.siRSM`

Value

`u0`	x-coordinates of surface's stationary point
`v0`	y-coordinates of surface's stationary point
`p10`	intercept in xy-plane of surface's 1st principal axis
`p11`	slope in xy-plane of surface's 1st principal axis
`p20`	intercept in xy-plane of surface's 2nd principal axis
`p21`	slope in xy-plane of surface's 2nd principal axis
`ax.congr`	slope of surface along the congruence line, `u-v=0`
`ax2.congr`	curvature of surface along the congruence line, `u-v=0`
`ax.incongr`	slope of surface along the incongruence line, `u+v=0`
`ax2.incongr`	curvature of surface along the incongruence line, `u+v=0`
`pl`	intersection of 1st axis at lower border, to be used by `plot.siRSM`
`ph`	intersection of 1st axis at upper border, to be used by `plot.siRSM`
`sl`	intersection of 2nd axis at lower border, to be used by `plot.siRSM`
`sh`	intersection of 2nd axis at upper border, to be used by `plot.siRSM`

Author(s)

Huan Cheng, Mu Zhu

References

Edwards JR (2002), "Alternatives to difference scores: Polynomial regression analysis and response surface methodology," in *Measuring and Analyzing Behavior in Organizations: Advances in Measurement and Data Analysis* (F. Drasgow, N. Schmitt, Eds.), Jossey-Bass, pp. 350-400.

`surface.test` *F-test of Curvature for the Response Surface*

Description

A standard nested F-test of linear (`f(u,v)~u+v`), interaction-only (`f(u,v)~u+v+I(u*v)`), and full-quadratic (`f(u,v)~u+v+I(u^2)+I(u*v)+I(v^2)`) models.

Usage

```
surface.test(object)
```

Arguments

`object`	an object of class '`siRSM`', often result from `siRSM`

Author(s)

Huan Cheng, Mu Zhu

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